Preface

The chance to write this textbook happened during the joint research and technical exchanges on pipe inspection robots by the two authors, Prof. Bishakh Bhattacharya from Indian Institute of Technology Kanpur (IITK) and Prof. Harutoshi Ogai from Graduate School of Information, Production and Systems (IPS), Waseda University.

Ogai came across upon a robot with integrated smart sensor for the piping inspection in the laboratory of Dr. Bhattacharya when he visited the Department of Mechanical Engineering, IITK, in 2008. At that time, while Ogai was focusing on the research of wireless sensor networks for bridge health monitoring system, a local Kitakyushu research team was developing an inspection robot for sewage pipe inspection (Kantarou). It was considered a research challenge on how to make the robot's radio communication system for movement inside the pipe. As described in this book, the radio characteristics inside the pipe were measured, and a type of wireless communication system was developed based on the measurement results. Also, the health monitoring system for the pipe was developed by using a video camera.

During this time, IITK had developed a pipe inspection robot that performed mechanical defect detection by touching pipe surfaces. The choice of touch-based sensor development was deliberate to avoid high-density data generation which could have created storage problem inside the robot.

Under such milieu, the two laboratories started extensive collaborative researches and student exchanges and carried out joint research on pipe inspection robots. They jointly developed a new prototype robot using both camera and mechanical touch sensing for inspection. Currently, the two laboratories are working together for developing pipe inspection robots for various applications including oil and gas pipelines.

The design, development, and experiments on the wireless communication systems discussed in this book were carried out jointly with the help of Hakutsu Technology Corporation, which contributed to the research and development of such systems in Kitakyushu now. As for the production of the main body of the robot, our sincere thanks are due to the cooperation of the Ishikawa Iron Works.

By showing some of the research achievements, this book is aimed at providing some reference and sharing experience on designing and producing pipe inspection systems to the university students and practicing engineers. As a reference to the actual pipe inspection, the book discusses the present condition of the inspection robot of the sewage pipe, the present inspection state of the gas pipe inspection robot, the design of the pipe inspection robot, the wireless communication characteristics of the pipe, the wireless communication system and the camera-based pipe inspection robot, the role of smart materials, smart sensors, structural health monitoring, and future pipe inspection robot technology.

It will be our honor if the book is found to be helpful in the development of future pipe inspection technology.

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